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ABSTRACT

The effects of varying the sequence of frames in a self-instructional program on the instructional outcomes of achievement, interest in learning, and attitudes toward programed instruction were investigated. Thirty-nine 6th grade Spanish classes were randomly assigned to a program with an orderly progression or a scrambled order of frames. The students worked on the program for 30 minutes each week without any teacher-directed instruction. For none of the three outcomes did the mean levels differ significantly after one semester of instruction. In each group a high relationship was found between aptitude and achievement and between initial attitudes and interest in learning. Attitudes toward programed instruction were not consistently related to any other variables. The conclusion was that small variations in sequence exert little effect on outcomes. (KB)

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RESEARCH BULLETIN

THE EFFECTS OF VARIATIONS IN A SELF-INSTRUCTIONAL PROGRAM ON INSTRUCTIONAL OUTCOMES

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THE EFFECTS OF VARIATIONS IN A SELF-INSTRUCTIONAL PROGRAM ON INSTRUCTIONAL OUTCOMES

Abstract

The effects of varying the sequence of frames in a self-instructional program on the instructional outcomes of achievement, interest in learning, and attitudes toward programed instruction were investigated. Thirty-nine sixth-grade Spanish classes were randomly assigned to a program with an orderly progression or a scrambled order of frames. The students worked on the program for 30 minutes each week without any teacher-directed instruction. For none of the three outcomes did the mean levels differ significantly after one semester of instruction. In each group a high relationship was found between aptitude and achievement and between initial attitudes and interest in learning. Attitudes toward programed instruction were not consistently related to any other variables. The conclusion was that small variations in sequence exert little effect on outcomes.

THE EFFECTS OF VARIATIONS IN A SELF-INSTRUCTIONAL PROGRAM ON INSTRUCTIONAL OUTCOMES[1]

One of the current controversies in programed instruction is the identification of variables that account for learning. Cook and Mechner (1962), for example, cite the following "elements combined by programed instruction to produce optimal learning":

(a) Active response by the learner;

(b) Small steps in which careful control of stimuli produces gradual increments in mastery of the subject;

(c) Immediate feedback for each response;

(d) Self-pacing;

(e) Low error-rate, which is a consequence of the preceding four principles.

They go on to write that "error-free learning is not only simpler, but its effects improve morale, motivation, and retention" (p. 5). These authors imply that the absence of the five principles they cite will result in lower levels of both cognitive and noncognitive outcomes.

The AERA-APA-DAVI Joint Committee on Programed Instruction and Teaching Machines (1963), on the other hand, has stated: "At present, the scientific evidence is not considered sufficient to . . . justify recommendation that adherence to specific rules of program construction be used as a basis for program evaluation. External evidence is recommended as the main basis for the evaluation of program effectiveness."

Both positions cited here accept the behavior of the learners as the criterion by which to evaluate a program, but they differ on whether the program's internal characteristics can predict this behavior.

The available empirical evidence tends to support the position of the Joint Committee. Studies which have measured the outcome of achievement (e.g., Ashbaugh, 1964; Coulson & Silberman, 1960; Evans, Glaser, & Homme, 1960; Goldbeck & Campbell, 1962; Jacobs & Kulkarni, 1963; Levin & Baker, 1963; Moore & Smith, 1964; Roe, Case, & Roe, 1962), have found only minor or non-significant effects by varying the type of response (overt vs. covert) and sequence of the frames (orderly vs. scrambled).

The present study included the noncognitive outcomes of interest in learning and attitudes toward programed instruction, as well as the cognitive outcome of achievement in assessing the effects of frame sequence in a program. The study also employed input characteristics in a dual role: first, as predictors that may account for the differences among the classes in a way that is meaningful to educators, and second, as covariance control variables that may increase the statistical precision of the experimental design.

Method

Subjects. The subjects were 824 students in 39 sixth-grade classes from the Denver Public Schools, Denver, Colorado.

Programs. A linear self-instructional program of 2016 frames, with a low error rate (5.7%) and a logical sequence, was developed to teach Spanish reading and writing to sixth-grade classes. The programing principles formulated by Skinner (1960) were carefully followed; first the behavioral objectives were specified in advance, then the frames were written, tried out, and revised until the learners performed satisfactorily. Because of the low error rate and the orderly progression of the frames, this version is

called the small-step version. The program was tried out in several schools prior to the present evaluation (Barcus, Hayman, & Johnson, 1961).

The sequence of frames of the small-step version was altered to produce a scrambled version. The alterations were not random; instead the frames within a unit were changed on an intuitive basis to break up the repetitiveness within each unit. The scrambled version was thus intended to be effective in producing learning and in stimulating interest. Its error rate of 7.1% was significantly higher (.01 level) than that for the small-step version (Hayman & Johnson, 1963).

Procedure. The program versions were randomly assigned to classes, with the restriction that the scrambled version be assigned to 22 classes in order to use up the existing supply of programs.

The classes worked on the programs for half an hour each Wednesday for one semester. No homework assignments or other instruction in Spanish reading and writing were given. The teachers, who were told not to answer any questions about Spanish, served only to maintain classroom order and to help with the mechanics of the program. Most teachers, in fact, did not know any Spanish.

The students also learned Spanish listening and speaking skills on Tuesdays and Thursdays, via televised and teacher-directed instruction. They had previously studied Spanish listening and speaking in the fifth grade, but had no prior instruction in Spanish reading and writing.

Input measures. The Kuhlman-Anderson Intelligence Test was used as the measure of academic aptitude; these scores were available from the school records. Initial attitudes toward Spanish (Preattitudes) were measured by the four-item inventory reproduced in Appendix A.

Outcome measures. Three kinds of instructional outcomes were used to evaluate the programs: (1) Achievement, (2) Attitudes toward Programed Instruction, and (3) Interest in Spanish. The Sixth Grade Spanish, Reading and Writing Test (Follett Publishing Co., 1964) was used to measure achievement at the end of the first semester. The test, which was used with classes taught by a variety of other methods as well as by the program alone, had a split-half reliability of .94 (Hayman & Johnson, 1963).

Attitudes toward Programed Instruction were measured by asking the students whether they preferred to learn various courses by a program alone, by a teacher alone, or by a combination of teacher plus program (items 2, 3, and 4 in Appendix B). The scoring of each item was dichotomized; a plus one was assigned to the alternative of learning by a program alone, and a zero was assigned to the other two alternatives. A high score reflected a desire to learn the courses by a program alone; a low score reflected a desire for teacher-directed instruction, either alone or in combination with a program. The internal consistency reliability of the attitude score was .60.

Interest in Spanish was measured by asking the student how frequently and for how many years he would like to study a foreign language, how much he enjoyed Spanish, and how often he read and conversed in Spanish on his own outside of school assignments (items 5-17 in Appendix B). The internal consistency reliability of the interest score was .86.

Results

Analyses of covariance were used to compare the effects of the program versions on the outcomes of Achievement (with Academic Aptitude as the control variable) and Interest in Spanish (with Preattitudes as the control

variable). Because no input measure was consistently correlated with the Attitude toward Programed Instruction score, the single classification analysis of variance was used with this outcome. The class, and not the individual student, was the sampling unit, and therefore the class mean served as the unit of observation in the analyses.

The results of the analyses of covariance and variance are shown in Table 1. The two versions of the program did not differ significantly in their effects on any of the three outcomes. During the one semester of instruction, the sequence of the frames did not exert a substantial effect on class learning, interests, or attitudes.

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Insert Table 1 about here

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The input characteristics of the class were substantially related to the outcomes of Achievement and Interest in Spanish. As shown in Table 2, the correlation of Aptitude with Achievement was high in both groups, .70 for the classes taught by the small-step version and .82 for the classes taught by the scrambled version. The correlation of Preattitudes with Interest in Spanish was almost as high, .50 and .71, respectively. The Attitudes toward Programed Instruction score was not correlated with Preattitudes for either version; it correlated positively with both Aptitude and Achievement for the small-step version, but negatively with them for the scrambled version. These correlations may be a result of chance rather than of systematic effects of the program version.[2]

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Insert Table 2 about here

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Discussion

Contrary to what may be expected from the principles of program development as stated by Cook and Mechner (1962), the variations in the program had little effect on the outcomes, both cognitive and noncognitive. The results of this study are consistent with much previous research and with the recommendations of the AERA-APA-DAVI Joint Committee on Programed Instruction and Teaching Machines (1963).

Both versions of the program tended to build upon the initial abilities and attitudes of the classes. Classes with high aptitude usually learned the most, and classes with the most favorable initial attitudes tended to have the highest level of interests at the end of the semester. Differences in outcomes were predictable by differences in input, but not by differences in the kind of program used for instruction.

In a larger study the small-step version used in combination with a trained Spanish teacher produced significantly more achievement than the program alone (Maier & Jacobs, 1964). This study also found that interest in learning was enhanced (a) by using the program as homework instead of classwork, and (b) by using the program with teacher-directed instruction plus making available a special corner of the classroom containing electronic aids, reading materials, and cultural artifacts (Hayman & Johnson, 1964). It appears that the level of outcomes, when not affected by differences in the program itself, may be affected by how the program is used.

One conclusion suggested by this and other research is that the effectiveness of a program may be relatively insensitive to changes within the program. To borrow a term from statistics, self-instructional programs may be called robust. In many cases the theoretical assumptions underlying the development of programs may not prove too important.

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Footnotes

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[2]As part of a larger study, the small-step version of the program was also used in combination with a trained Spanish teacher. For 15 classes taught by the combination of teacher plus program, the Attitude toward Programed Instruction score correlated -.44 with Aptitude and -.53 with Achievement. Since there is no obvious substantive explanation of why the correlations should vary so, the best explanation may be that the correlations arose by chance.

Table 1

Analysis of Outcomes

Outcome	Source of Variation	DF	Mean Square[a]	F
A. Achievement (Predictor: Aptitude)	Program Versions	1	25.6	1.4 NS
	Error	36	18.3	
B. Interest in Spanish (Predictor: Preattitudes)	Program Versions	1	.005	.004 NS
	Error	36	1.3	
C. Attitudes toward Programed Instruction (Predictor: none)	Program Versions	1	.025	.4
	Error	37	.063	

[a]Adjusted Mean Squares shown for the outcomes of Achievement and Interest in Spanish.

Table 2

Results for Two Versions of a

Self-Instructional Program

A. Small-step Version (N = 17 Classes)

		Input			Outcome			
		1	2	3	4	5	Mean	S.D.
1.	Aptitude		-01	70	04	75	106.5	6.6
2.	Preattitude	-01		07	50	-08	[illegible]	.54
3.	Achievement	70	07		-06	74		[illegible].7
4.	Interest in Spanish	04	50	-06		-11	[illegible]	1.1
5.	Programed Instruction Attitudes	75	-08	74	-11		.47	.21

B. Scrambled Version (N = 22 Classes)

		Input			Outcome			
		1	2	3	4	5	Mean	S.D.
1.	Aptitude		-02	82	-19	-32	103.5	8.3
2.	Preattitude	-02		21	71	-03	4.7	.66
3.	Achievement	82	21		16	-27	20.2	7.8
4.	Interest in Spanish	-19	71	16		-01	10.3	1.6
5.	Programed Instruction Attitudes	-32	-03	-27	-01		.52	.27

Note:- Decimal points have been omitted from the correlations.

Appendix A

Sixth Grade Enrollment Form - Page 3

The following four questions deal with your opinions about taking Spanish. Please check one answer for each question -- whichever best describes how you feel. Remember, your answer will not have any bearing on your marks or your standing in the class, so please answer honestly.

16. How long would you like to study Spanish?

- ☐ I would like to drop Spanish right now
- ☐ Just this year, but no more
- ☐ More than just this year

17. Do you think Spanish should be taught in the sixth grade?

- ☐ No
- ☐ Yes
- ☐ I'm not sure

18. How much did you enjoy Spanish last year?

- ☐ About the same as my other subjects
- ☐ More than my other subjects
- ☐ Less than my other subjects
- ☐ I did not study Spanish last year

19. Did studying Spanish help you in English?

- ☐ No
- ☐ Yes
- ☐ I'm not sure

Your Name_____ Teacher's Name_____

School_____

STUDENT QUESTIONNAIRE

Last year in the fifth grade you learned how to speak Spanish. Now as sixth graders you are learning how to read and write Spanish. Some of you are learning to read and write Spanish from your teacher, others are learning from Automated Spanish, a programmed textbook, and still others from your teacher and programmed textbooks.

Here are some questions about Spanish and about the way you are learning it.

Read each question and the possible answers.
Decide on your answer.
Put a check mark like this ✓ next to the answer you choose.
Make sure you answer each question.

1. How are you now learning to read and write Spanish?

_____ a. From my teacher

_____ b. From programmed textbooks

_____ c. From my teacher and programmed textbooks.

2. If you had your choice, how would you want to learn Spanish reading and writing?

_____ a. From my teacher

_____ b. From programmed textbooks

_____ c. From my teacher and programmed textbooks.

3. If you had your choice, how would you want to learn arithmetic?

_____ a. From my teacher

_____ b. From programmed textbooks

_____ c. From my teacher and programmed textbooks

4. If you had your choice, how would you want to study English?

_____ a. From my teacher

_____ b. From programmed textbooks

_____ c. From my teacher and programmed textbooks

5. If you had your choice, what foreign language would you like to learn in the sixth grade?

_____ a. French
_____ b. German
_____ c. Latin
_____ d. Spanish
_____ e. Russian
_____ f. No foreign language

6. If you had your choice, what foreign language would you like to learn in high school?

_____ a. French
_____ b. German
_____ c. Latin
_____ d. Spanish
_____ e. Russian
_____ f. No foreign language

7. How much did you enjoy learning to speak Spanish last year?

_____ a. More than my other subjects
_____ b. About the same as my other subjects
_____ c. Less than my other subjects

8. How much do you enjoy learning to read and write Spanish this year?

_____ a. More than my other subjects
_____ b. About the same as my other subjects
_____ c. Less than my other subjects

9. How often do you read Spanish newspapers, stories, and so forth on your own? Do not include your reading for class assignments.

_____ a. Rarely or never
_____ b. Once in a while
_____ c. Often

10. How often do you translate Spanish on your own?

_____ a. Rarely or never
_____ b. Once in a while
_____ c. Often

11. How often do you think in Spanish when you are not working on your class assignments?

_____ a. Rarely or never
_____ b. Once in a while
_____ c. Often

12. How often do you speak to your friends in Spanish?

_____ a. Rarely or never
_____ b. Once in a while
_____ c. Often

13. How often do you speak to your parents in Spanish?

_____ a. Rarely or never
_____ b. Once in a while
_____ c. Often

14. How often would you like to take Spanish this year?

_____ a. Every day
_____ b. 4 times a week
_____ c. 3 times a week
_____ d. Twice a week
_____ e. Once a week
_____ f. Not at all

15. How long would you like to study Spanish?

_____ a. I would like to drop Spanish right now
_____ b. Just this year, but no more
_____ c. More than just this year

16. Do you think studying Spanish helps you with English?

_____ a. No
_____ b. Yes
_____ c. I'm not sure

17. Do you think studying Spanish helps you figure out the meaning of new English words?

_____ a. No
_____ b. Yes
_____ c. I'm not sure